Camera Link Line Scan Cameras

SwordFish

Camera User's Manual

SF-10-XXK40-02-R

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1 Introduction

1.1. Overview

The SwordFish series of line scan cameras, available in 1k to 2k resolutions, Cabling and interface are with the Camera Link Base standard. SwordFish is with features of high responsivity, enhanced blue response and wide dynamic range, and so on. This camera is especially suitable for industrial applications such as color sorting and web inspection. In addition to electronic shutter, programmable analog gain, offset and external trigger function, the camera incorporates flat-field correction function. Equipped with a variety of camera lens adapters, the camera can be connected with many standard lenses to meet the users' needs.

1.2. Image Sensor

This camera incorporates Teledyne DALSA's image sensor IL-P3-B with 14 µm square pixels, 100% fill factor and resolutions of 1024 or 2048 active pixels. As shown in Figure 1, the IL-P3-B CCD operates with a single tap.

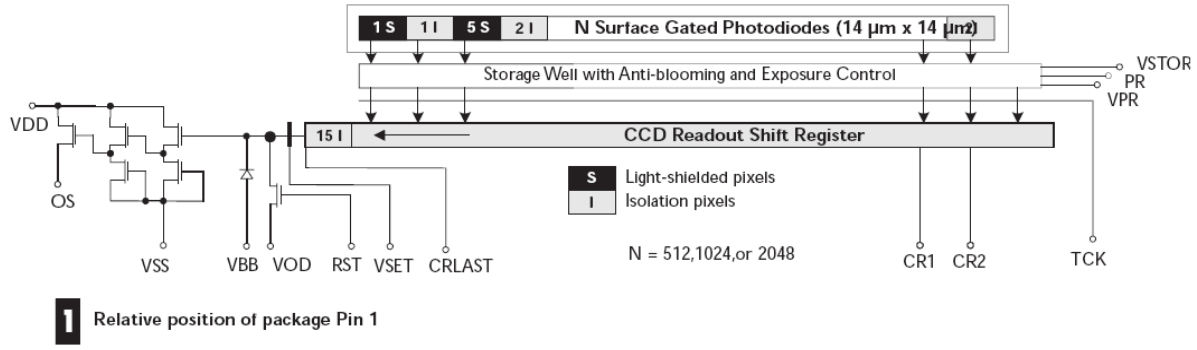


Figure 1: IL-P3 Image Sensor Block Diagram

The IL-P3-B CCD, with enhanced blue response, is a high responsivity sensor with a peak of 43 V/(uJ/cm²). This sensor also has a high dynamic range up to 1820:1(65dB). These features make the CCD ideal for applications in color sorting and web inspection.

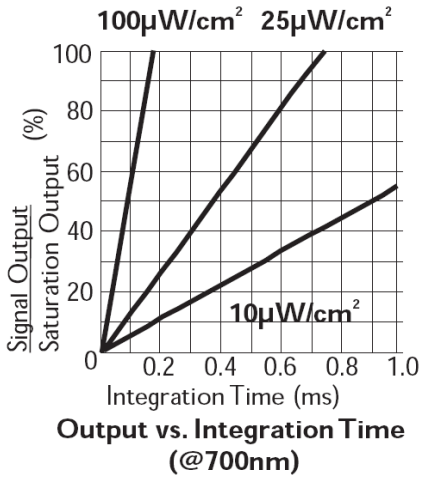


Figure 2a IL-P3-B CCD spectral response

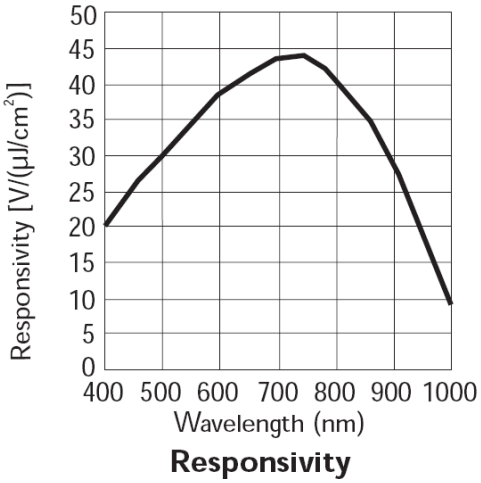


Figure 2b IL-P3-B CCD responsivity

2 Performance Specifications

Table 1 Performance Specifications

Features			Note
Resolution	1024 pixels	2048 pixels	
Color/mono	Black and white		
Pixel clock Speed	40MHz	40MHz	
Tap	1	1	
Pixel size	14 μm x 14 μm	14 μm x 14 μm	
line rate	1 kHz -36 kHz	1 kHz -18 kHz	
Dynamic range	60 dB	60 dB	
Bit depth	Programmable, 8 bit / 10 bit / 12 bit		
Trigger	External or internal		
Mechanical interface/Electrical interface			
Power	< 6.0 W @ 12 VDC (±20%)		
Interface	Camera Link™ (Base)		
Data Connector	MDR26 (female)		
Installation Accuracy of CCD	<0.1mm		
Lens Mount	M42×1(Spiral Shape)，(conformity F,PK or MD)，mount C not used in 2k pixels		
Housing Size (L x W x H)	66 mm x 74 mm x 55 mm		

Weight	≤500 g (without adapters)	
Storage Temperature	-20 to 60 °C	
Operation Temperature	10 to 50 °C	
Shock	15 g, half sine, 11 ms	
Vibration	Random vibration in three directions: x,y,z. 4.88m/s2 , 0-1500 Hz	
Function		
Analog Gain Range	-12 dB to +20 dB	
Analog Offset	0 to 255 DN	
Programmable integration time, line rate		
Programmable bit depth, test pattern, and diagnostics		
Supporting FFC(Flat-field correction)		

3 Precaution

Read this manual carefully before using the camera.

Confirm that the camera's packaging is undamaged before opening it. If the packaging is damaged please contact the related logistics personnel.

Do not open the housing of the camera. The warranty becomes void if the housing is opened.

Keeps the camera housing temperature in the range of 10 to 50 °C during operation. Otherwise the red alarm light will turn on and the alarm instructions will be fed back to the host computer. If this happens, the camera will not turn off automatically, users should set by themselves.

Be sure not to operate the camera in the vicinity of strong electromagnetic fields. Avoid electrostatic charging, violent vibration, and excess moisture.

Customers can choose different lens options. We provide variety of lens adapters to meet the ideal performance specifications.

To clean the CCD, avoid electrostatic charging by using a dry, clean absorbent cotton cloth dampened with a small quantity of pure alcohol. Do not use methylated alcohol. To clean the surface of the camera housing, use a soft, dry cloth. To remove severe stains, use a soft cloth dampened with a small quantity of neutral detergent, then wipe dry. Do not use volatile solvents such as benzene and thinners; they can damage the surface finish.

No support hot plugging, please make sure disconnect the power of camera before you do it.

4 Installation

4.1 Interface Description

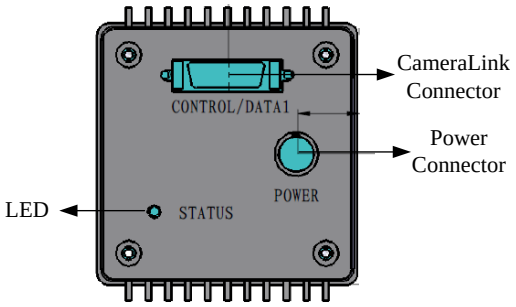


Figure 3. Camera Inputs/Outputs

4.1.1 Data Connector

The camera uses standard Camera Link base interface. Figure 4 shows the MDR26 Connector.

Key Features:

- Ports: A, B, C
- Serial data bit depth: 28 bit
- Number of the sensors: 1
- Number of the MDR26 connectors: 1

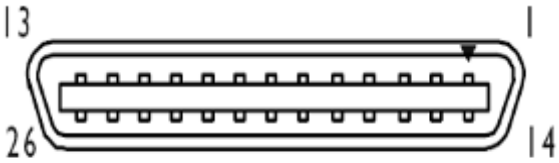


Figure 4 MDR26 Connector

Table 2 Definition of each pin of Camera Link

Camera Connector	Right Angle Frame Grabber	Camera Link		Camera connector	Right Angle Frame Grabber	Camera Link
1	1	inner shield		19	8	X3+
14	14	inner shield		7	20	SerTC+
2	25	X0-		20	7	SerTC-
15	12	X0+		8	19	SerTFG-

3	24	X1-		21	6	SerTFG+
16	11	X1+		9	18	Exsync-
4	23	X2-		22	5	Exsync+
17	10	X2+		10	17	PRIN+
5	22	Xclk-		23	4	PRIN -
18	9	Xclk+		11	16	CC3-
6	21	X3-		24	3	CC3+

a. The 28 bit imaging data, including video and control signal such as LVAL, FVAL, and DVAL, are transmitted through the four pairs of signal wires: (X0-, X0+), (X1-, X1+)， (X2-, X2+) and (X3-, X3+). For the line scan cameras the control signal is LVAL and the other two are invalid. LVAL is defined HIGH for valid pixels.

b. (Xclk- , Xclk+), namely STROBE, the inputs for pixel clock, operates at a pixel clock rate of 40MHz. This camera's data should be sampled on the rising edge of STROBE.

c. (SerTC+, SerTC-) and (SerTFG-, SerTFG+), Serial Communication Interfaces, are used for the camera to communicate with the host computer.

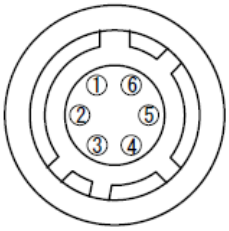
d. (Exsync-, Exsync+; PRIN+, PRIN –) and (Exsync-, Exsync+; PRIN+, PRIN –) are two pairs of inputs for the external trigger signal of exposure mode. This camera uses the edge of Exsync to trigger line readout and PRIN for pixel reset. The characteristics of the two signals and their applications are specified in section 5.3.

e. (CC3+, CC3-) and (CC4-, CC4+) are invalid.

4.1.2 Power Connector

Table 3 shows the pins and the descriptions of the power connector (Hirose 6-pin). The P/N is HR10A-7R-6PB.

Table 3 power connector (Hirose 6-pin)



Pin	Description	Note
1	+12 V	The three pins are internal connected.
2	+12 V	
3	+12 V	
4	GND	The three pins are internal connected.
5	GND	
6	GND	

The camera requires a single voltage input. The recommended voltage is +12 V (± 20%). The camera meets all performance specifications using standard switching power supplies. Well regulated linear supplies, which Teledyne DALSA recommends, provide optimum performance. When setting up the camera's power supplies follow these guidelines:

- Protect the camera with a fast-blow fuse between the power supply and camera.
- Do not use the shield on a multi-conductor cable for ground.

- Check the order of power and ground, the camera will be damaged if the order is converse.
- Keep leads as short as possible to reduce voltage drop.

4.1.3 LED Status Indicator

The camera is equipped with a red/green LED used to display the operational status of the camera. The following table summarizes the operating states of the camera and the corresponding LED states.

Table 4 States of the camera and the corresponding LED

LED state	Priority	Camera Status	Condition	Blinking Period
Steady RED	1	Warning	Current camera temperature exceeds specific limit	
Blinking GREEN	2	Progress	Lengthy operation in progress	200 ms
Steady GREEN	3	OK	Healthy	

Note: When more than one status happen at a time, the LED shows the status of the highest priority. There are corresponding information of error and warning status to describe the current states of a camera.

4.2 Installation Overview

- Connect Camera Link™ cables from camera to standard Camera link frame grabber.

  As an alternate, you can apply the camera link cable assembly manufactured by 3M. The maximum allowed length for the MDR cable used with the SwordFish camera is 10 meters.

  Connect power cables from camera to the voltage source. For proper EMI protection, the power supply cable attached to this plug must be a twin-cored, shielded cable. Also, the housing of the Hirose plug must be connected to the cable shield and the cable must be connected to earth ground at the power supply.

4.3 Mechanical Interface

The SwordFish camera applies a M42 × 1 mount. It can be connected to varied standard lenses with different adapters, such as the C-Mount, F-Mount, PK-Mount, and so on. Users can choose a lens appropriate for their applications. Table 5 lists the lens mounts and their back focal distance.

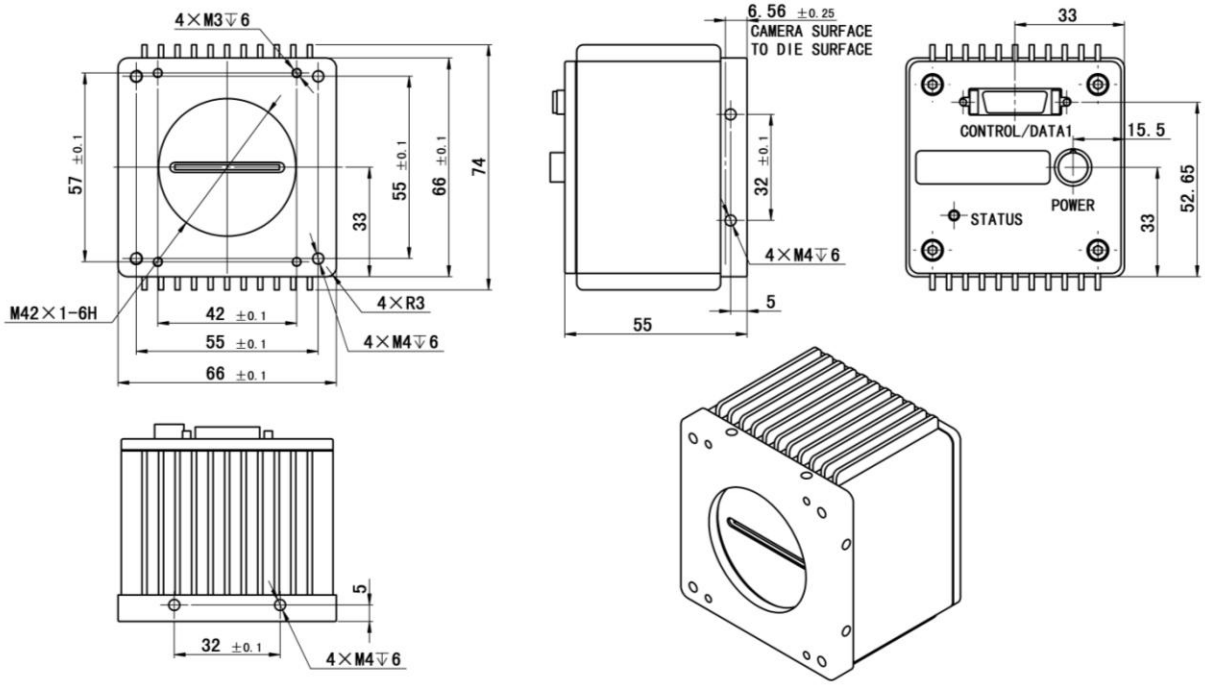


Figure 5 Mechanical Interface

Table 5 The lens mount and the back focal distance

Mount	Back Focal Distance (sensor die to adapter)
C-Mount	17.52 ±0.25 mm
F-Mount	46.5 ±0.25 mm
PK-Mount	45.5 ±0.25 mm

5 Functions and Commands

5.1 Software Interface

The camera transfers information to and from the host through the RS-232C communication port. To set commands at the HyperTerminal, refer to the following:

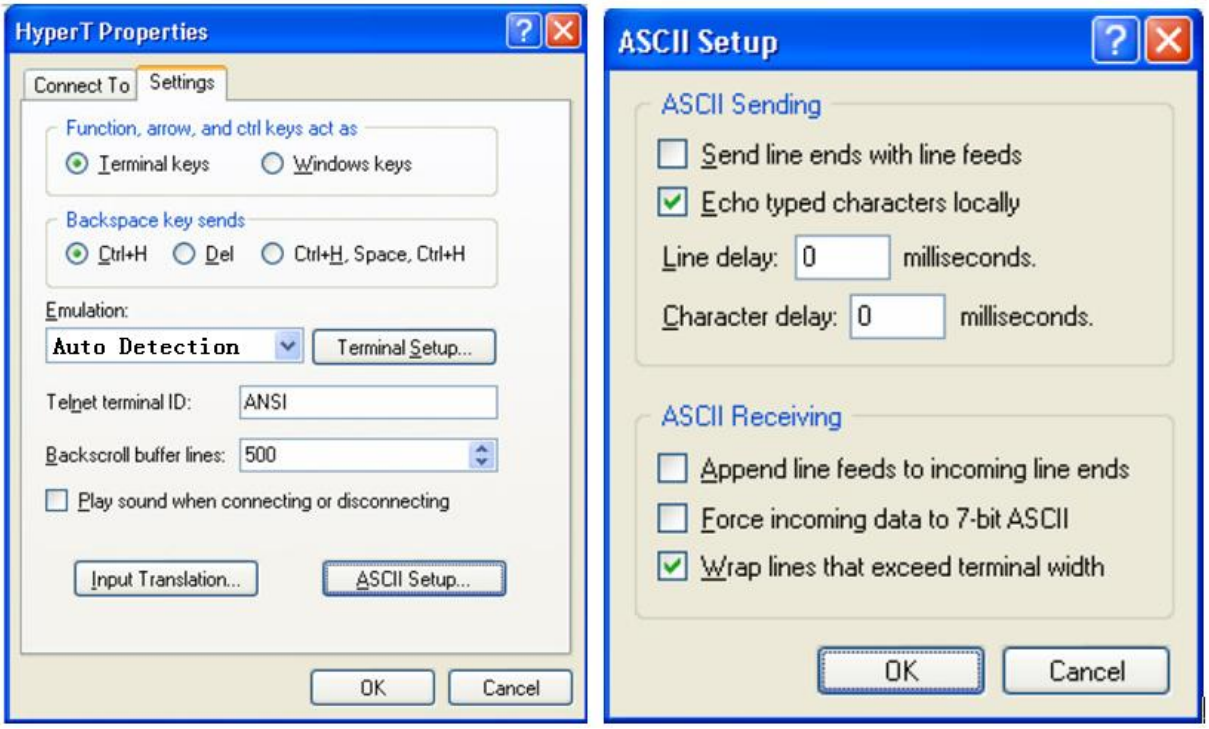


Figure 6 HyperTerminal settings

- Note: You cannot amend the incorrect commands. Instead, enter a carriage return and input the correct commands again. In the ASCII setup, check “Echo typed characters locally” and you will see the typed characters at the HyperTerminal.

The user can also choose to use a third-party serial control software for debugging.

5.2 Command Format

The instructions commonly include four parts: key words, parameters, space character and end mark (a carriage return (CR)). The total length of the characters is not more than 32. The command format is as follows:

Key [parameter1] [parameter2]

a. Key words: Instruction words, four characters at most, normally within three characters. Different functions have different instruction characters. Refer to Appendix A for details.

b. Parameters: optional, two at most. The description is as follows: i = integer, f = float, t = tap selector, s = string, x1 = pixel start number, x2= pixel end number, [] = optional parameter. The floating-point parameters must have three digits after the decimal point.

c. Space characters: at least one. More than one is permissible.

d. End mark,” \r”, is also named carriage return (CR).

5.3 Exposure Mode

The camera's line rate (synchronization) is generated internally or input from a frame grabber/host system. With six different exposure modes setting by the command sem i, the camera delivers many possibilities for flexible camera timing. When the camera is powered on for the first time, it defaults (no external input required) to exposure mode 2. Table 6 outlines each of these six exposure modes.

Table 6 Exposure Modes

Mode	SYNC	PRIN	Programmable line rate	Programmable exposure time	Description
1	Internal	Internal	No	No	Maximum line rate and exposure time
2	Internal	Internal	Yes	Yes	Programmable line rate and exposure time
3	External	Internal	No	No	Maximum exposure time
4	External	Internal	No	No	Smart EXSYNC
5	External	External	No	No	External line rate and external pixel reset
6	External	Internal	No	Yes	Fixed integration time

Some exposure modes have some similarities in timing, Refer to Figures 7 to 10 for timing details of the six different exposure modes. The values set by user can be saved by the command '**wus**' under programmable modes.

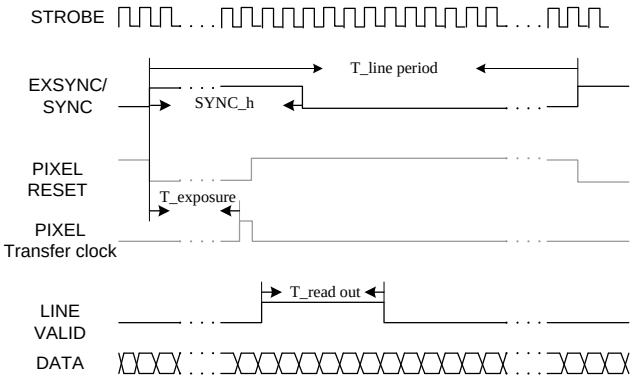


Figure 7 Timing for exposure mode 2 and exposure mode 6

Exposure mode 2 is internal trigger mode, used **set** command to set **T_exposure**, range is from 1.750us to **T_line period**, internal trigger signal is **SYNC**, used **ssf** command to set line frequency =1/ **T_line period**, **T_line period** range is from 54054ns to $1.61*10^6$ns in 2k pixels, or from 27777ns to $1.61*10^6$ns in 1k pixels. The timing of exposure mode 2 in figure 7.

Exposure mode 6 is external trigger mode, used **set** command to set **T_exposure**, range is from 1.750us to **T_line period**, external trigger signal is **EXSYNC**, that is **CC1** input. The camera uses **the rising edge of EXSYNC** to trigger line readout , **SYNC_h** > 75ns. The timing of exposure mode 6 in figure 7.

pixel reset and pixel transfer clock are internal signal.

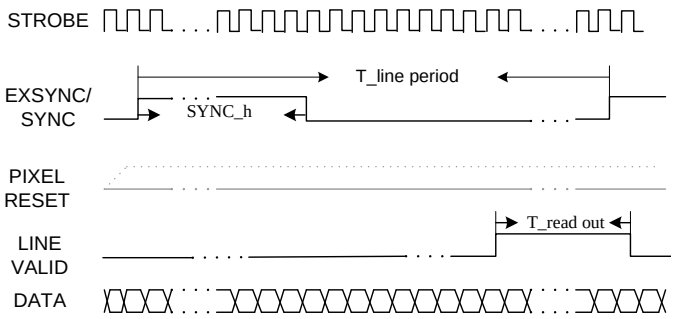


Figure 8 Timing for exposure mode 1 and 3

Exposure mode 1 is internal trigger mode, camera output Maximum frequency and Maximum exposure time. The timing of exposure mode 1 in figure 8.
Exposure mode 3 is external trigger mode, camera output Maximum exposure time in current frequency, external trigger signal is **EXSYNC**, that is **CC1** input. The camera uses **the rising edge of EXSYNC** to trigger line readout , **SYNC_h** > 75ns. The timing of exposure mode 3 in figure 8.
pixel reset is internal signal.

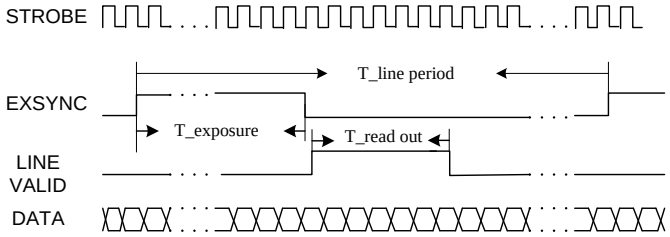


Figure 9 Timing for exposure mode 4

Exposure mode 4 is also called smart mode in that the exposure time and line rate are both controlled by the external trigger signal **EXSYNC**, that is **CC1** input. The exposure starts on the rising edge of the signal and the charges are transferred on the falling edge. The pulse width of **EXSYNC** high level, namely the exposure time(**T_exposure**), is not allowed to be less than 2 μs. The period of **EXSYNC** is the same with the line period, The timing of exposure mode 4 in figure 9.

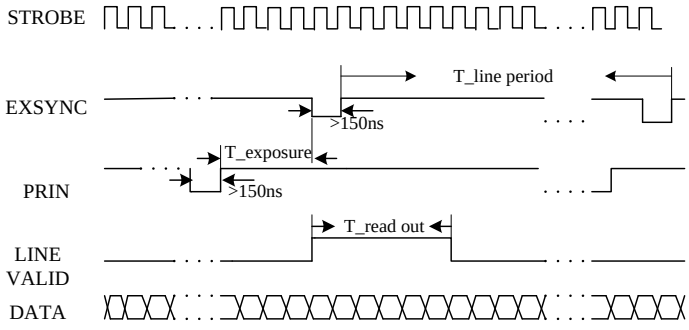


Figure 10 Timing for exposure mode 5

In mode 5,the two signals **EXSYNC** and **PRIN** are both necessary, **PRIN** is a signal used to reset the pixels. The exposure starts on **the rising edge of the PRIN** and the charges are transferred on **the**

falling edge of the EXSYNC. **EXSYNC** is the line rate signal, the frequencies are the same for the two signals. The width of the low pulse is larger than 150 ns. The timing of exposure mode 5 in figure 10.
T_read out is 51200ns in 2k pixels, or 25600ns in 1k pixels in all figure.

Note:EXSYNC should not be clocked faster than the camera's specified maximum line rate. The camera ignores the EXSYNC pulse until it has completed reading the last line out.

More details for the related instructions are as follows:

a. Setting Exposure Mode

Set exposure mode, using the sem command:

Command: set_exposure_mode
Syntax: sem i
Syntax Elements: i
Factory setting is mode 2 with 5kHz line rate and maximum exposure time.
Notes: To obtain the current value of the exposure mode, use the command sem or gcp.
Related Commands: ssf, set
Example: sem 2
Prompt: OK>

b. Setting Line Rate

To set the line rate, use the command ssf. Camera must be operating in exposure mode 2.

Command: set_sync_frequency
Syntax: ssf i
Syntax Elements: i
Line rate unit : Hz , line rate range: 620Hz～18639Hz in 2k pixels or 620Hz～36000Hz in 1k pixels.
Notes: To read the current line rate frequency, use the command ssf or gcp. If you input an invalid line rate frequency, the valid range of values will be displayed.
Related Commands: sem, set
Example: ssf 3000
Prompt: Exposure Time Set To Max Of xxx.xxx uSec !
Note：There is no deviation between the Set value and the Effective value.

c. Setting Exposure Time

To set the camera exposure time, use the command 'set'. Camera must be operating in exposure mode 2 or 6.

Command:set_exposure_time
Syntax: set f
Syntax Elements: f
f - Floating point number in unit μsecs. For allowable range 1.750 ~ 1612.9 [μs], see the camera help screen (h command).
Notes: To read the current exposure time, use the command set or gcp. If you enter an invalid exposure time, the valid range of values will be displayed.
Related Commands: sem, ssf
Example: set 100

Prompt: OK>

5.4 Video Mode

The video mode sets whether the camera is running in calibrated or uncalibrated mode, or if it is running in test mode. For the uncalibrated mode, the image data is read out without any calibration. In calibrated mode, images are output after FFC. Test mode is especially useful for service purposes and for camera failure diagnostics.

5.4.1 Test Mode

To set the test mode, use the command **svm** 2. The test image is formed with gray value (scale gradient) that ranges from 0 DN (stepping up) to 2047 DN (in 12 bit Data mode). Test mode is used for failure diagnostics of the connection from the camera to the grabber card. Figure 11 shows the test result.

Figure 11 test image

5.4.2 FFC

This camera has the capability to calibrate itself in order to remove non-uniformity in the image. This video correction operates on a pixel-by-pixel basis and implements a two point correction for each pixel. This correction can reduce or eliminate image distortion caused by the following factors:

- Fixed Pattern Noise (FPN)
- Photo Response Non Uniformity (PRNU)
- Lens and light source non-uniformity

The two point correction is implemented such that for each pixel:

Voutput = (Vinput - FPN(pixel) - digital offset) * PRNU(pixel)

Where Voutput = digital output pixel value
Vinput = digital input pixel value from the CCD
PRNU(pixel) = PRNU correction coefficient for this pixel
FPN(pixel) = FPN correction coefficient for this pixel

The calibration algorithm is performed in two steps. The fixed offset (FPN) and the digital offset are determined first by performing a calibration without any light. This calibration determines exactly how much offset to subtract per pixel in order to obtain flat output when the CCD is not exposed. The white light calibration is performed next to determine PRNU correction coefficient required to bring each pixel to the required value (balance target) for flat, white output.

To perform FFC, do the following:

1. Send the following commands through serial interface
   svm 1 //Set the calibrate mode.
2. Set the operating parameters (such as line rate, exposure time, analog offset, analog gain, for example).
3. Set line sample number, using command **css** (the default is 64 lines).
4. Operate the camera in darkness, covering the lens with a lens cap. Verify the output signal level is within the valid range of 0 to 511 DN for 10 bit data mode, using command **gl** or **gla**. If the signal level is too low, adjust the analog offset (**sao**). If the signal level is too high, ensure that no light is entering the camera; reduce the analog offset or the gain level (**sg**).
5. Perform dark calibration, using command **ccf**. If the calibration is accomplished, the camera returns OK>. Otherwise the camera returns an error message. Dark calibration automatically calibrates FPN coefficients and digital offset.
6. After the calibration is complete, you can save these settings and the PRNU coefficients so they will be remembered after power-down. To do so, issue the command **wus** and **wpc**.
7. Place a clean white uniform reference in front of the camera. White paper is often not sufficient because the grain in the white paper will distort the correction. White plastic or white ceramic will lead to better balancing.
8. Make sure that the camera is in exposure status, with the lens cap off and white reference as imaging object. Verify the output signal level is within the valid range of 512 to 1007 DN for10 bit data mode, issuing the command **gl** or **gla**. If the signal level is too low or too high, adjust the analog gain level, using command **sg**.
9. Instruct the camera to perform a white light calibration by using the command **ccp**. The camera will return with OK> if no error occurs.
10. After the calibration is complete, you can use the **wus** command to save these settings. To save PRNU and FPN coefficients, issue the command **wpc**. Otherwise, the current settings will be lost after power-down.

The related commands are as follows:

a. Setting the Video Mode

Using command svm i, the Video Mode Sets whether the camera is running in calibrated, uncalibrated mode or test mode.

Command: set_video_mode
Syntax: svm i
Syntax Elements: i
Allowable value the Video Mode:
0: uncalibrated mode, invalid video correct
1: calibrated mode, valid video correct
2: test patten right
Notes: To set the current video mode, use the command svm or gcp.
Example svm 1
Prompt: OK>

b. Set the FPN coefficient

Command: set_FPN_coefficient
Syntax: sfc i i
Syntax Elements: i : the pixel number from 1 to 2048 in 2k pixels or from 1 to 1024 in 1k pixels.

i : Coefficient value in a range from 0 to 127.

Example: sfc 10 50

c. Read the FPN coefficient

Syntax: gfc i
Syntax Elements: i: the pixel number to read.
Example: gfc 10: continually show 16 FPN coefficients from the beginning of pixel 10.

d. Set the PRNU coefficient

Syntax: spc i i
Syntax Elements: i: the pixel number from 1 to 2048 in 2k pixels or from 1 to 1024 in 1k pixels.

I: Coefficient value in a range from 0 to 511.

Example: spc 10 50

e. Read the PRNU coefficient

Syntax: gpc i
Syntax Elements: I; the pixel number to read.
Example: gpc 10: Continually show 16 FPN coefficients from the beginning of pixel 10.

5.5 Data Mode

The camera provides three valid output data modes: 8 bit, 10 bit and 12 bit. To select the data mode, use the command sdm.

a. Setting the Data Mode

Command: set_data_mode
Syntax: sdm i
Syntax Elements: i
0 8-bit, 1 10-bit, 2 12-bit
Notes: To obtain the current data mode, use the command sdm or gcp.
Example: sdm 2
Prompt: OK>

5.6 Offset and Gain

a. set_analog_offset

Command: set_analog_offset
Syntax: sao t i
Syntax Elements: t; Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since this is a one tap camera, the values 1 or 0 are interchangeable.

i Analog offset value. Allowable range is 0 to 1023.

Notes: The image gray value will grow when increasing the value of i. The increasing amount of gray value is close to 1/4 of the setting value . For example, a setting value of 100 will result in an gray value offset of about 25 DN. The command can be used in uncalibrated mode and test mode.

Example: sao 0 200
Prompt: OK>

b. Subtracting Offset in Calibrated Mode

You can subtract the A/D offset from the video signal prior to PRNU correction, available only in calibrated mode. In other modes the cameras will return an error.

Command: set_digital_offset
Syntax: sdo t i
Syntax Elements: t Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since this camera is a one tap camera, the values 1 or 0 are interchangeable.
i Subtracted offset value in a range from 0 to 511.

Notes: The offset digital value is subtracted from the digital video signal, so it is not allowed to exceed the signal value.

Example: sdo 0 100

c. Calibrating Offset

Set the average output level to a specific value, adjusting the analog offset value.

Command: calibrating_analog_offset
Syntax: cao t i
Syntax Elements: t Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since this camera is a one tap camera, the values 1 or 0 are interchangeable.
i The line average in a range dependent on the current camera data mode setting.
8 bit: 1 to 14DN;
10 bit: 4 to 62DN;
12 bit: 16 to 249DN.

Notes: The command is valid in uncalibrated mode. The second parameter presents the average signal value. It can be set different in varied modes as shown above.

Example: cao 0 100

d. set_analog_gain

Command: set_analog_gain
Syntax: sg t f
Syntax Elements: t Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since this camera is a one tap camera, the values 1 or 0 are interchangeable.
f Gain setting. Range: -12 - +20dB (Here the gain means the gain of the analog image signal). .
Example: sg 0 -12

e. set_digital_gain

Command: set_digital_gain
Syntax: ssg t i
Syntax Elements: t Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since this camera is a one tap camera, the values 1 or 0 are interchangeable.
i Gain setting. The gain range is from 0to 511(equal to a gain from 1 to 1.999).
Gain (multiple) = (Gain (DN) + 512) / 512.
Example: ssg 1 15

f. Calibrating analog Gains

Set the average output level to a specific value, adjusting the analog gain. This function requires a constant light input while it executes. This feature is beneficial for achieving a common output level for multiple cameras in a system.

Command: calibrating_analog_gain
Syntax: cag t i
Syntax Elements: t Tap selection. Allowable values are 1 for one tap or 0 for all taps. Since the camera is a one tap camera, the values 1 or 0 are interchangeable.
i Line average in a range dependent on the current camera data mode setting:
8 bit: 64 to 251 DN;
10 bit: 256 to 1007 DN;
12 bit: 1024 to 4031 DN;

Notes: This function, valid in uncalibrated mode, requires a constant light input while it executes. The allowable range of the output value is dependent on the current data mode, as shown above.

Related Commands: gla, gl

Example: cag 1 156

5.7 Returning Video Information

The camera's microcontroller has the ability to read video data. This functionality can be used to verify camera operation and to perform basic testing without having to connect the camera to a frame grabber. This information is also used for collecting line statistics for calibrating the camera.

a. Returning a Single Line of Video

Command: Get_line
Syntax: gl [x1] [x2]
Syntax Elements:
[x1] Optional parameter. This sets the start pixel to display on screen. Allowable range is from 1 to 2048 in 2k pixels or from 1 to 1024 in 1k pixels. This parameter does not affect the Min, Max, and Mean statistics generated at the end of the line output.
[x2] Optional parameter. This sets the end pixel to display on screen. Allowable range is (x1 + 1) to sensor pixel count 2048 in 2k pixels or pixel count 1024 in 1k pixels. This parameter does not affect the Min, Max, and Mean statistics generated at the end of the line output.

Notes: If you do not specify a pixel range to display, the line output will display all sensor pixels on screen. The Min, Max, and the statistic region of Mean of the end of the line are the region of interest (roi).

Values returned are in DN.
Example: gl 10 20

b. set the number of lines to sample

Syntax: css i
Syntax Elements: i Number of lines to sample. Allowable values are 16, 32, or 64 (factory setting).

Notes: To return the current setting, use the command css and gcp.

Example: css 32

c. Returning Multiple Lines of Video

Syntax: gla [x1] [x2]
Syntax Elements:
[x1] Optional parameter. This sets the start pixel to display on screen. Allowable range is from 1 to 2048 in 2k pixels or from 1 to 1024 in 1k pixels.. This value does not affect the Min, Max, and Mean statistics generated at the end of the line output.
[x2] Optional parameter. This sets the end pixel to display on screen. Allowable range is (x1 + 1) to sensor pixel count 2048 in 2k pixels or pixel count 1024 in 1k pixels. This value does not affect the Min, Max, and Mean statistics generated at the end of the line output.

Notes: When this function executes, the sample lines, set by the css command, and collected and averaged.

If you do not specify a pixel range to display, the line output will display all sensor pixels on the screen.
If a region of interest has been set using the roi command, the Min, Max, and Mean statistics at the end of the line output include statistics for the region of interest only.
Values returned are in DN.

Example: gl 10 20

5.8 Setting a Region of Interest

The command roi sets the pixel range used to collect the end of line statistic and sets the region of pixels used in the cag, cao, gl, gla, ccf, and ccp commands. To define a region of interest, use the roi command.

Command: region_of_interest
Syntax: roi x1 x2
Syntax Elements:
x1 : Pixel start number in a range from 1 to sensor pixel count 2048 in 2k pixels or pixel count 1024 in 1k pixels. It must be less than the pixel end number.
x2 :Pixel end number in a range from (x1 + 1) to sensor pixel count 2048 in 2k pixels or pixel count 1024 in 1k pixels. It must be greater than the pixel start number.
Related Commands: gl, gla
Example: roi 10 50
Prompt: OK>

5.9 Query Command

a. Read the camera ID, using command gci.

Command: get_camera_id
Syntax: gci
Prompt: Camera Network ID: 0

b. Read the camera serial number, using command gcs.

Command: get_camera_serial
Syntax: gcs
Prompt: Camera Serial No.: xxxxxxxx

c. Read the firmware version, using command gcv.

Command: get_camera_version
Syntax: gcv
Prompt: Firmware Design Rev.: SF2KFMBxxx
FPGA Design Rev.: SF2KFFBxxx

d. Display the online help, using command h.

Command: help
Syntax: h
Prompt: Command: ……
Command: ……

6 Troubleshooting

6.1 No Image

Follow the steps in chart 6.1 to diagnose your camera if you see no image at all with camera power and the LED indicator on.

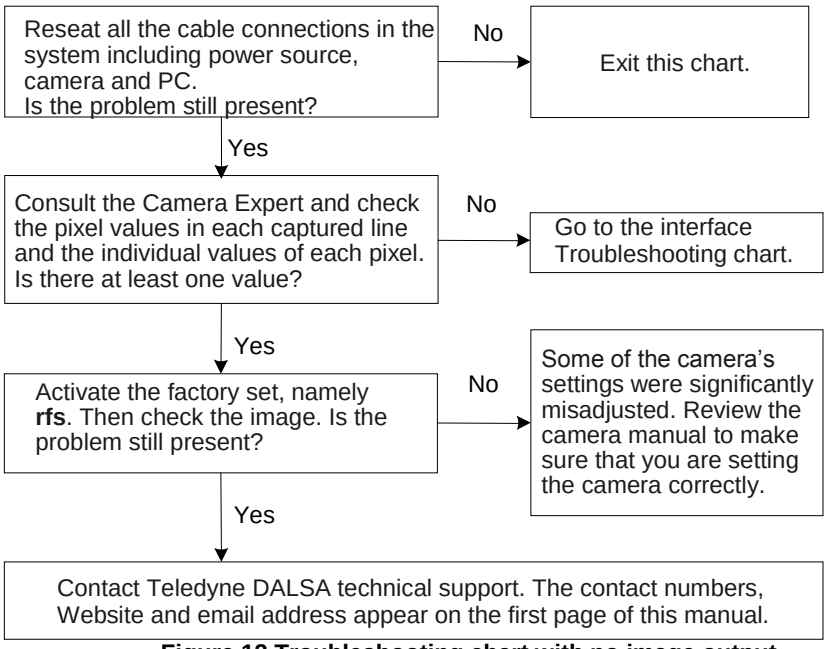

Reseat all the cable connections in the system including power source, camera and PC.
Is the problem still present?
No
Exit this chart.
Yes
Consult the Camera Expert and check the pixel values in each captured line and the individual values of each pixel.
Is there at least one value?
No
Go to the interface Troubleshooting chart.
Yes
Activate the factory set, namely **rfs**. Then check the image. Is the problem still present?
No
Some of the camera's settings were significantly misadjusted. Review the camera manual to make sure that you are setting the camera correctly.
Yes
Contact Teledyne DALSA technical support. The contact numbers, Website and email address appear on the first page of this manual.

Figure 12 Troubleshooting chart with no image output

6.2 Poor Quality Image

If the image is in poor quality, check whether the lens is clean. Then you can follow chart 6.2 to solve the problem.

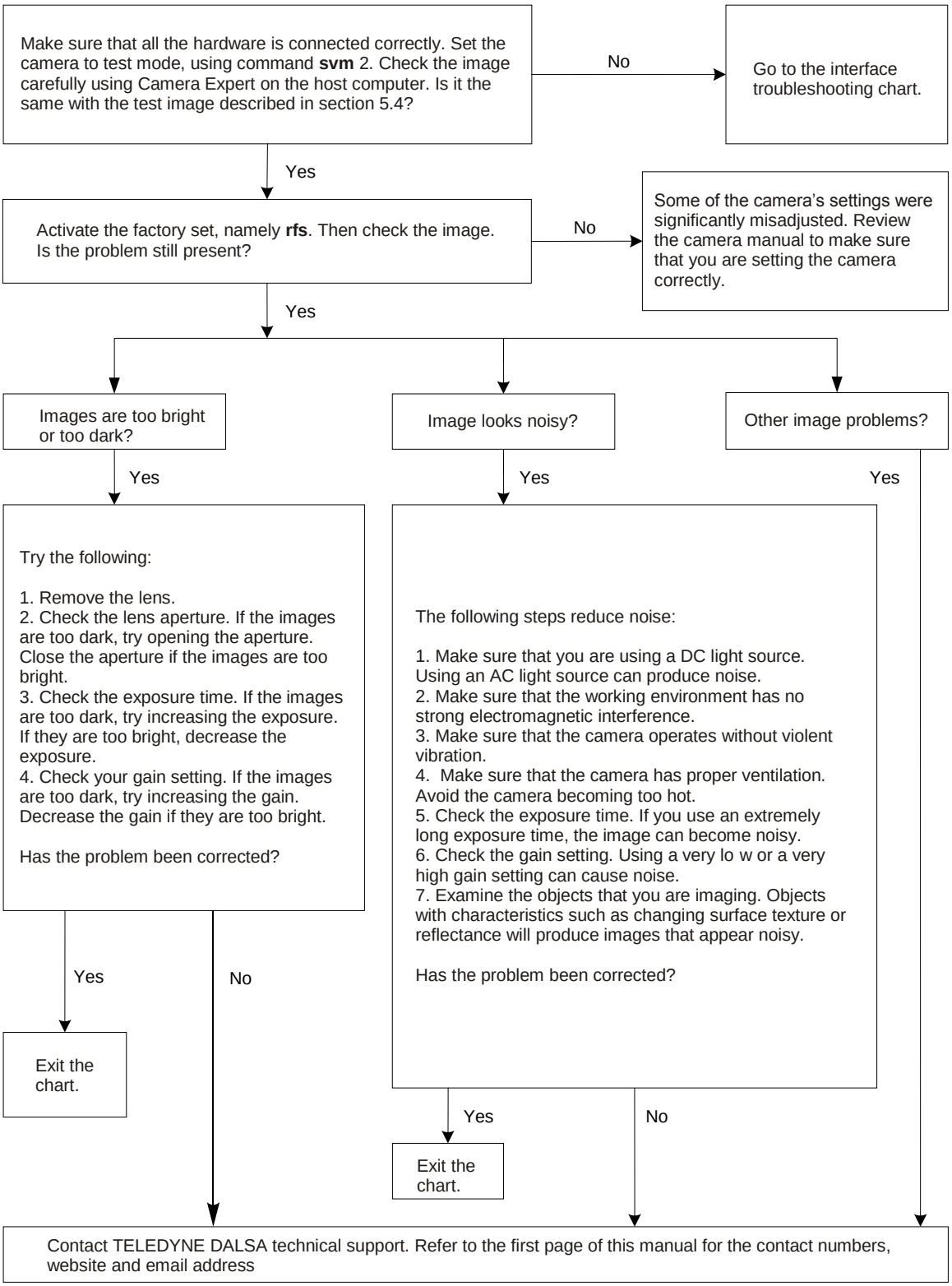

Make sure that all the hardware is connected correctly. Set the camera to test mode, using command **svm** 2. Check the image carefully using Camera Expert on the host computer. Is it the same with the test image described in section 5.4?
No
Go to the interface troubleshooting chart.
Yes
Activate the factory set, namely **rfs**. Then check the image. Is the problem still present?
No
Some of the camera's settings were significantly misadjusted. Review the camera manual to make sure that you are setting the camera correctly.
Yes
Images are too bright or too dark?
Image looks noisy?
Other image problems?
Yes
Yes
Yes
Try the following:
1. Remove the lens.
2. Check the lens aperture. If the images are too dark, try opening the aperture. Close the aperture if the images are too bright.
3. Check the exposure time. If the images are too dark, try increasing the exposure. If they are too bright, decrease the exposure.
4. Check your gain setting. If the images are too dark, try increasing the gain. Decrease the gain if they are too bright.
Has the problem been corrected?
The following steps reduce noise:
1. Make sure that you are using a DC light source. Using an AC light source can produce noise.
2. Make sure that the working environment has no strong electromagnetic interference.
3. Make sure that the camera operates without violent vibration.
4. Make sure that the camera has proper ventilation. Avoid the camera becoming too hot.
5. Check the exposure time. If you use an extremely long exposure time, the image can become noisy.
6. Check the gain setting. Using a very lo w or a very high gain setting can cause noise.
7. Examine the objects that you are imaging. Objects with characteristics such as changing surface texture or reflectance will produce images that appear noisy.
Has the problem been corrected?
Yes
No
Yes
No
Exit the chart.
Yes
No
Exit the chart.
Contact TELEDYNE DALSA technical support. Refer to the first page of this manual for the contact numbers, website and email address

Figure 13 poor image quality trouble shooting chart

6.3 Interfacing Troubleshooting

If you see no image signal with the camera power-on, it is Mostly because that your camera does not have all the correct connections or part of the components cannot work well. Try to solve the problems referring to chart 6.3.

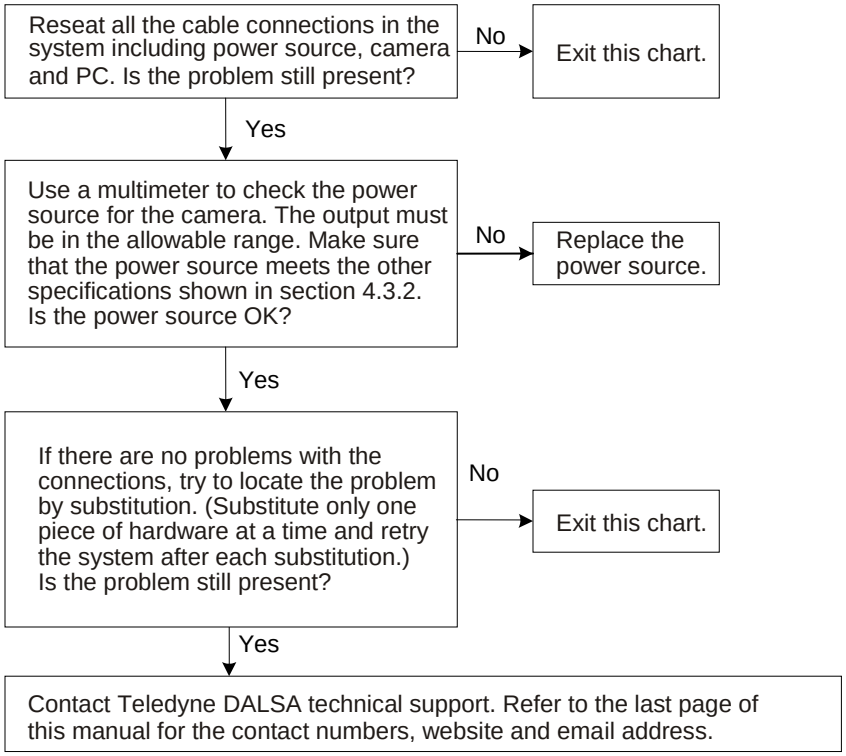

Reseat all the cable connections in the system including power source, camera and PC. Is the problem still present?
No
Exit this chart.
Yes
Use a multimeter to check the power source for the camera. The output must be in the allowable range. Make sure that the power source meets the other specifications shown in section 4.3.2. Is the power source OK?
No
Replace the power source.
Yes
If there are no problems with the connections, try to locate the problem by substitution. (Substitute only one piece of hardware at a time and retry the system after each substitution.) Is the problem still present?
No
Exit this chart.
Yes
Contact Teledyne DALSA technical support. Refer to the last page of this manual for the contact numbers, website and email address.

Figure 14 interface troubleshooting chart

6.4 Other Problems

In case of any other problems that cannot be solved, contact Teledyne DALSA Technical Support.

Appendix A

a) Camera Commands

SN	PC commands (control commands)	Commands	Parameters1	Parameters2	Note
1	calibrate_analog_gain	cag	t (0/1)	i (64 - 251)	8 bit data mode
				(256 - 1007)	10 bit data mode
				(1024 - 4031)	12 bit data mode
2	calibrate_analog_offset	cao	t (0/1)	i (1 - 14)	8 bit data mode
				(4 - 62)	10 bit data mode
				(16 - 249)	12 bit data mode
3	correction_calibrate_fpn	ccf			
4	correction_calibrate_prnu	ccp			
5	correction_set_sample	css	i (16/32/64)		16lines
					32lines
					64lines
8	get_camera_id	gci			
9	get_camera_model	gcm			
10	get_camera_parameters	gcp			
11	get_camera_serial	gcs			
12	get_camera_version	gcv			

SN	PC commands (control commands)	Commands	Parameters1	Parameters2	Note
13	get_fpn_coeff	gfc	i (1 – PN[1])		Continually show 16 parameters from the beginning of pixel i.
14	get_line	gl	i (1 - PN[1])	i (1 - PN[1])	Specify the display range.
15	get_line_average	gla	i (1 – PN[1])	i (1 – PN[1])	Specify the display range.
16	get_prnu_coeff	gpc	i (1 - PN[1])		Continually show 16 parameters from the beginning of pixel i.
17	get_sensor_serial	gss			
18	help	h			
19	region _of_interest	roi	i (1 - PN[1])	i (1 - PN[1])	
20	reset_camera	rc			
21	reset_pixel_coeffs	rpc			
22	restore_factory_settings	rfs			
23	restore_user_settings	rus			
24	set_analog_offset	sao	t (0/1)	i (0 - 1023)	
25	set_baud_rate	sbr	i (9600/19200/57600/115200)		9600/19200 /57600/115200
26	set_camera_id	sci	s (A-Z/0-9)		
27	set_data_mode	sdm	i		8 bit

SN	PC commands (control commands)	Commands	Parameters1	Parameters2	Note
			(0 - 2)		10 bit
					12 bit
28	set_digital_offset	sdo	t (0 - 1)	i (0 - 511)	Valid in calibrated mode only.
29	set_exposure_mode	sem	i (1 - 6)		
	set_exposure_time	set	f (1.750-1612.9)		Mode 2
					Mode 6
30	set_fpn_coeff	sfc	i (1 - PN[1])	i (0 - 127)	
31	set_gain	sg	t (0 - 1)	f (-12 - +20)	
32	set_prnu_coeff	spc	i (1 - PN[1])	i (0 - 511)	
33	set_sync_frequency	ssf	i (620 - 18639 Hz) in 2k pixels (620 - 36000 Hz) in 1k pixels		Mode 2
34	set_system_gain	ssg	t (0 - 1)	i (0 - 511)	
35	set_video_mode	svm	i (0 - 2)		0 :Uncalibrated video
					1: Calibrated video
					2: Test pattern
36	verify _temperature	vt			
37	verify_voltage	vv			
38	write_pixel_coeffs	wpc			Write current FPN and PRNU
39	write_user_settings	wus			Write all of the user settings

NOTES：1. PN is 1024 in 1k pixels number，or 2048 in 2k pixels number.

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Version	Data	Description of Revisions
00	2009-09-09	Initial release
01	2011-01-04	Modify some inaccurate description
		Improve the resolution of the mechanical drawing
02	2014-07-10	1. Change the range of parameters under the command “sao” and “cao” . 2. Eliminate the deviation between the set value and effective value when using command “ssf” in exposure mode 2 3. Upgrade the Firmware version and FPGA version. 4. Change the camera model From”SF-10-02K40-01-R” to ” SF-10-02K40-02-R”